Kinsley (N.W.)

MECHANISM OF SPEECH.

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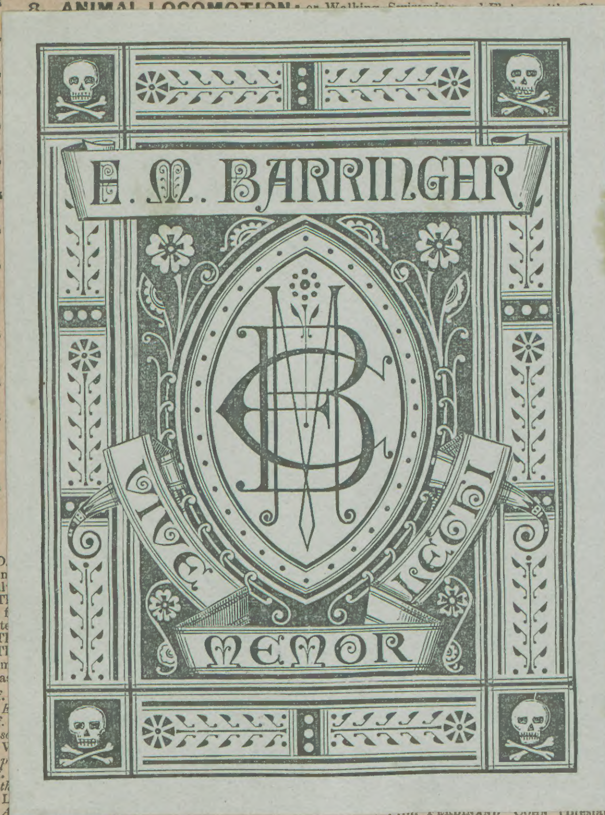

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SOME INVESTIGATIONS INTO THE MECHANISM OF SPEECH.

Having been incidentally engaged for many years in observing some peculiar phenomena in articulate speech by persons with defective organs, which were unexplained by any authority to which I had access, I was led into an original investigation of the mechanism of speech with both normal and abnormal organs.

Articulate language is an aggregation of definite sounds associated with definite ideas, which in the progress of time has become so complex a system that nearly every idea of the most subtile brain can be conveyed to another mind by sound alone, and from habit we come to regard the idea and the words which express it as almost identical.

It is difficult to think, and impossible to reason, without our thoughts formulating themselves into words. But thoughts were not first formed into words and then uttered in speech: words are the outgrowth of the effort to express ideas by sound and the combinations of sounds.

It is the natural instinct of a child to express its general

want by sound, and as it develops in intellect and its wants become more definite, it adopts from its superiors the sounds which express its specific wants.

So habituated are we from infancy to interpreting sounds as expressing definite ideas, that few of us ever realize that this is one of the most wonderful functions possessed by man.

All articulate speech must of necessity be acquired; there can be no natural language. The accepted arrangement of sounds is purely arbitrary and derives its power from the common consent and use of such arrangement; in this way isolated communities tend to form dialects and in time apparently different languages.

Articulate speech is based upon the physics of sound, a knowledge of the latter being essential to a comprehension of the mechanism of the former. All sounds, whether harmonious or discordant, are caused by the vibrations of matter. Musical sounds and noises are equally the result of vibrations; the first being the result of periodic or regular-recurring vibrations, and the second of those which are irregular, confused, non-periodic. Wherever there is sound there is motion, and conversely, wherever there is motion there might be sound, if there were a medium by which the vibrations were conducted to our ears, and our ears were capable of apprehending the vibrations. As our ears are constituted, they will not appreciate a sound which is the result of less than sixteen vibrations to the second, nor will they take cognizance of sound when the vibrations exceed 40,000 per second.

The vibrations which reach our ears may arise from a multitude of causes. They may originate in the air itself, or in some substance far removed and conveyed by the air to us. No sound emanating from whatever cause and heard by the ear as a single sound, is a simple sound. It is always a compound or composite one, made up of a number of tones of different intensity and pitch, together with a possible admixture of noises, which combined constitute the sound as heard.

The fundamental tone is always associated with tones higher or lower in pitch, or with both, which modify it. The

difference in the quality or timbre of the same musical note as emanating from different instruments, such as the violin, clarionet, and organ, is due to the different admixture of overtones and undertones with the fundamental note.

One of the most interesting phenomena of the physics of sound is its augmentation or reinforcement by secondary causes. A hollow body, as a short tube, for example, closed at one end, containing a column of air of a certain length, can be made to resound by bringing its open end near a sounding body.

The sound emitted throws the column of air within the tube into motion, and these vibrations, being identical with those of the sounding body, augment or reinforce the original note. If the column of air in such a resonating tube is not in unison with any tone of the combination or clang, no response will be heard; but if in unison with any tone of the clang, such tone will be augmented or reinforced. Thus a resonating body may augment the fundamental tone—or by unison with one of the overtones or the undertones, will reinforce that to the exclusion of all others. A hollow body or resonating cavity depends for its power upon its form and dimensions rather than upon the substance of its walls. The recognition of this phenomenon is the key to the mechanism of speech.

The human voice is caused by the action of the expiratory muscles driving the breath outward through the larynx. The sound produced by vibrations of the vocal chords is not a simple sound, but a clang. The buccal cavity and the nasal cavity become resonators; the palate, tongue, jaws, cheeks, lips, and nostrils being capable of altering and modifying the form and dimensions of these cavities to a very great extent; but whatever shape they assume they will have, like all other hollow bodies filled with air, their own tone-character in each different form and dimension. Consequently, as the sound passes out through the mouth some one tone of the clang which is in unison with the tone-character of the buccal cavity at that moment will be augmented and intensified. This reinforcement by resonance changes the quality or timbre of the laryngeal clang.

"In this changed timbre consists the nature of vowel sounds. A vowel is the timbre which results from the increase by resonance of one or more tones in the laryngeal clang." * *Pure vowel sounds can be made only by resonance of the buccal cavity alone and in its normal integrity.*

Let any other cavity communicate with it and its tone-character is destroyed, and *par consequence* the purity of its vowel sounds; make a communication with the nasal cavity, either great or small, and pure vowel sounds are impossible. The power to change the shape and size of the oral cavity being great, equally great is its power to change the laryngeal clang. This change of timbre in the clang may be continuous and uninterrupted within the compass of the voice, from the lowest tones to the highest; and what are called the different vowel sounds are but points along this vocal stream which our ears distinctly mark and separate one from another.

Articulate language may adopt as many divisions of this vocal stream as the ear can distinguish, but practically it is not desirable to burden a language with *extremely nice shades of sound.*

Max Müller says: "Vowels in all their varieties are really infinite in number." As a precise statement this can not be correct, and as an approximate statement it is only theoretically true.

The human voice is heard only within certain limits, and practically there can be no more vowels than appreciable changes of timbre and pitch within those limits.

The five most distinctly marked vowel sounds used in the English language are OO, O, AH, A, E.† These five vowels are not to be confounded with the five vowel letters of the Eng-

* Professor Elsberg.

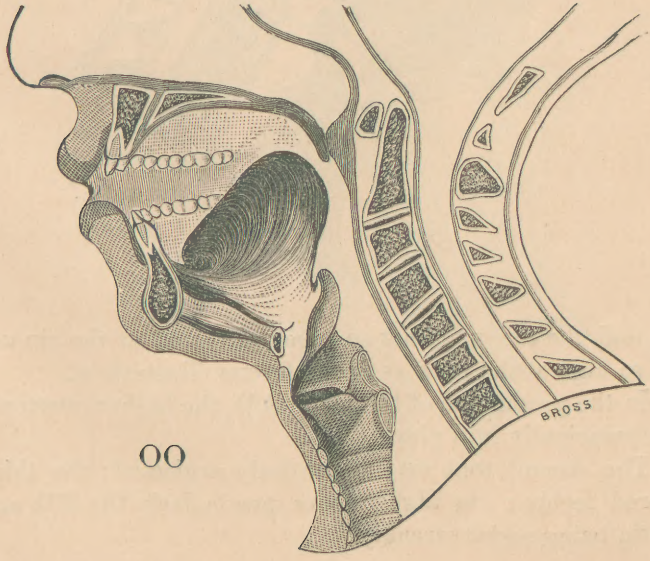
† Dr. Bristowe, in a recent lecture before the Royal College of Surgeons, England, makes *thirteen* vowel sounds in the English language, which he illustrates by the fundamental vowel in each of the following syllables or words: *past*, *pat*, *pet*, *pate*, *pit*, *peat*, *pauper*, *pot*, *potent*, *put*, *boot*, *pur*, *putty*. But even this illustration will not suffice to convey a clear apprehension of his designations. The words which he has chosen are not pronounced uniformly wherever English is spoken. Cultivated scholars use a different vowel in some of them from what the lecturer evidently intended.—("London Lancet," April, 1879, p. 507.)

lish alphabet, a, e, i, o, u. The English names of these letters do not express the distinction between the principal vowels as well as the Italian pronunciation of the same letters. OO is the original Anglo-Saxon name for U. In English the sounds AH and A, which are distinctly separated in the laryngeal clang, are expressed by one letter, in Italian the same sounds are expressed by A and E.

The written vowels in both languages are the same, but the spoken vowels represented by them differ; we are obliged, therefore, to adopt the designations of OO, O, AH, A, E, to express in English the five principal vowels.

These sounds constitute the fundamental vowels of nearly all the languages of the world. In the production of these vowels, according to Tyndall, the laryngeal clang undergoes the following changes: "For the production of U (oo in hoop) I must push my lips forward so as to make the cavity of the mouth as deep as possible, at the same time making the orifice of the mouth small. This arrangement corresponds to the deepest resonance of which the mouth is capable. The fundamental tone of the vocal chords is here reinforced, while the higher tones are thrown in the shade."

FIG. 1.

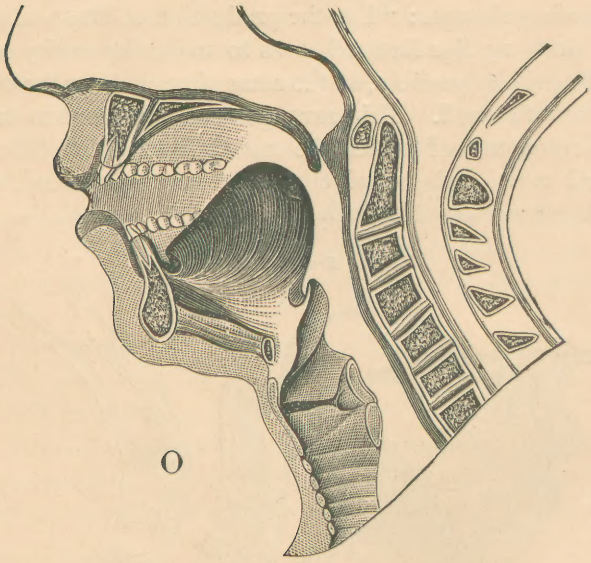


In Fig. 1 is shown the position which the tongue, palate, and lips assume in making OO. The tip of the tongue is much depressed in the floor of the mouth and its back lifted high toward the soft palate, but it does not touch the roof of the mouth at any point; the jaws are opened and the lips contracted, so that the oral cavity becomes bottle-shaped, and the passage through the nares is completely shut off by the conjunction of the palate and pharyngeal wall.

"The vowel O is pronounced when the mouth is so far opened that the fundamental tone is accompanied by its strong, higher octave."

In Fig. 2 the organs are represented; the lips are not so

FIG. 2.

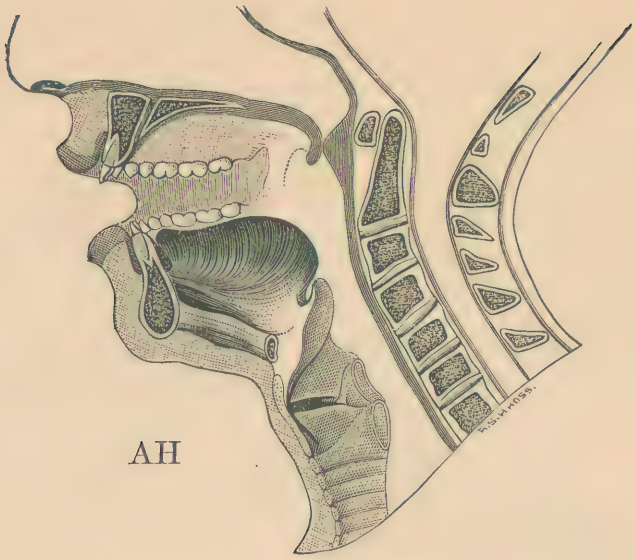


close, and the tongue is not so much retracted at the tip nor lifted so high at the back as in the former illustration.

"In the production of the sound AH, the higher overtones come principally into play.

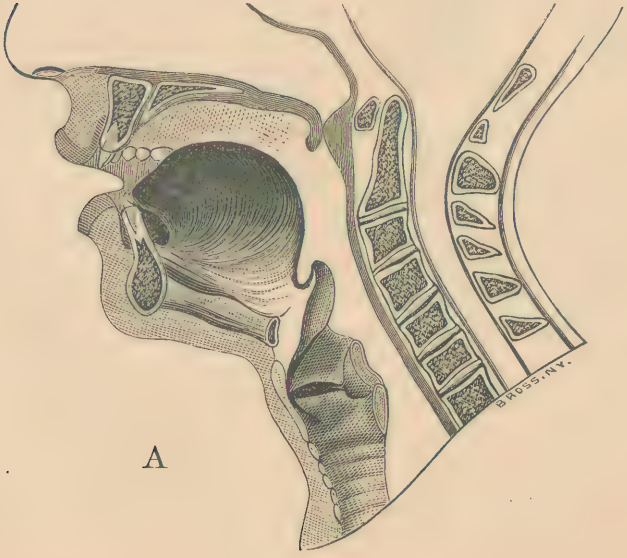
"The second tone may be entirely neglected; the third rendered feebly; the higher tones, particularly the fifth and seventh, being added strongly."

Fig. 3.



In Fig. 3, illustrating the organs during this sound, we see the oral cavity distended to its greatest capacity; the mouth

Fig. 4.



is wide open; the tongue lies comparatively flat, and the veil of the palate is lifted to its highest elevation.

To make a resonating cavity which shall produce AH, some persons curl the sides of the tongue upward in the form of a trough, while in others the same cavity is formed with the tongue full along the median line.

"The vowel A derives its character from the third tone, to strengthen which by resonance the orifice of the mouth must be wider, and the volume of air within it smaller than in the production of O. The second tone ought to be added in moderate strength, while weak fourth and fifth tones may also be included with advantage."

In Fig. 4 the marked change from AH is seen in the elevation of the tongue, and a reduction in the dimensions of the vocal tube. We find now, for the first time thus far, the tongue touching the roof of the mouth.

Fig. 5.

This contact is shown in Fig. 5 by the black patches on the alveolar border against the molar teeth.

The method by which this was determined is described further on.

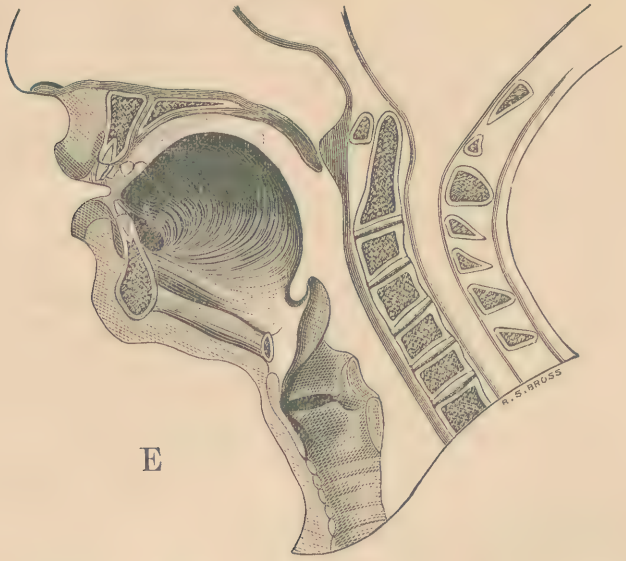
"To produce E, the fundamental tone must be weak, the second tone comparatively strong, the third very feeble; but the fourth, which is characteristic of this vowel, must be intense. In order to exalt the higher tones which characterize the vowel sound E, the resonant cavity of the mouth must be small."

In Fig. 6 we see the tongue lifted higher than in making any preceding vowel, and the resonant cavity, in both form and dimensions, in striking contrast with that of OO.

In E, it partakes of the nature of an elongated tube. The reduction of the vocal passage is also seen in Fig. 7, where

the contact of the tongue is shown to extend the whole length of the sides of the alveolar border.

Fig. 6.



The foregoing five illustrations cover the entire compass of vowels from the highest to the lowest; all the others heard by Bristowe, and more even as claimed by some find their relative position somewhere between the extremes of E and U (OO).

Fig. 7.

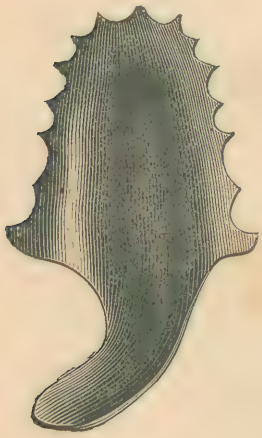
It will be observed that in each of the sectional illustrations the soft palate is elevated, the pharyngeal wall bulges forward, and the uvula lies in firm contact against it. This shutting off the nasal cavity is essential to the purity of vowel sounds. If there be any escape of breath or sound, however small, behind the curtain of the palate, the vowels will be nasalized.

This is the explanation of the peculiar vowels of the French language. In addition to those used in English, there are several which are characterized by resonance of the nasal cavity, showing that, at the time of their formation, the palate and pharyngeal wall are relaxed. These nasal vowels are essential to the perfection of the French language, but when introduced into English destroy its purity.

This is a loose habit of speech among some English-speaking people into which large communities have fallen. By a slack conjunction of the posterior border of the palate and the pharyngeal wall the whole speech is affected disagreeably.

The illustrations here used are the result of personal studies of the organs in action in many cases, and are the record of one mouth in particular with well-developed organs. The means adopted were as follows:

Fig. 8.



I made a cast of the roof of a mouth extending back and down to the boundary of the fauces, and upon this cast fitted a very thin and delicate plate of black vulcanite, covering the entire roof within the teeth and the palate.

Two or three such plates were made, duplicates of each other in the roof of the mouth, but varying in the palatine portion. One of these plates is shown in Fig. 8. In this one, the sides of the posterior or palatine portion have been cut away, leaving a tongue extending down to the uvula; one of the others covered the whole palate, and in another the whole palatine portion was cut away.

When used to test articulation, one of them was painted with a film of chalk, wet up with alcohol so that it would dry quickly, and then introduced into the mouth, and the sound to be experimented upon made clearly and distinctly as possible, and the plate removed. If the tongue touched the roof

of the mouth, the teeth, or the palate in any part, the white surface of the chalk was removed, exposing with the utmost distinctness the black surface in contact. The form of the contact in a given sound was delineated upon a clean plaster cast of the roof of the mouth, and the experiment continued with the same or some other sound. Those plaster casts were copied in the foregoing and following illustrations.

These experiments were repeated over and over again with the same sounds at different times and on different days, until uniformity was proven and the various plaster casts became a record of the exact position of the tongue in making these sounds.

The separations of the jaws and lips were determined accurately by measurement, the varying positions of other organs by repeated observation and other tests, and all drawn to a uniform scale and here reduced. They are therefore consistent with each other. But it must be borne in mind that, even if it were possible to obtain absolutely accurate models of the organs of speech while in action, of any number of cases, it is not probable that any two of them would be exactly alike.

It is not supposable that all persons in making the same sound place the active accessory organs—the tongue, palate, etc.—in the same identical position. Variations to a greater or less extent can be observed in every one. Exactly the same resonating cavity in *shape* is not likely to exist in any two jaws. With the fixed portion of any buccal cavity differing somewhat in form from every other, the changeable portions, such as the tongue and palate, adapt themselves to the circumstances and produce a resonating cavity of the same tone-character. The variations in the position of the articulating organs as seen in different persons in producing the same sound are then understood. So long as the integrity of the accessory organs is preserved a resonating cavity of like tone-character can be formed.

The scope of this paper will not permit an analysis or explanation of the mechanism of all the sounds that combine to form articulate language. As it is intended solely for the English reader, no attempt will be made to describe

such sounds as may form an important element of other languages, but which are not heard in any word in English. To a reader who is unfamiliar with a foreign language it is very difficult to convey other than by vocal demonstration, an apprehension of those sounds which are peculiar to that language. Nor shall we undertake an investigation into certain nice distinctions of pitch, timbre, and tone, which would lead us away from our main object. We shall rather confine ourselves to the distinct sounds of the English language appreciable to nearly all ears, and represented by characters or letters. The difference between these is so well marked and the mechanism of their formation so positive that we can discover it, describe it, and illustrate it.

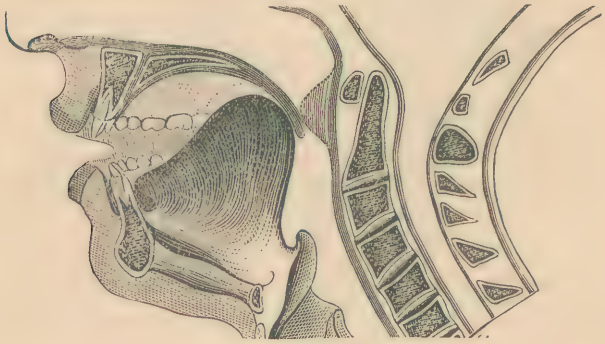
Articulate speech is made up of vowel and other sounds—pure, interrupted, or checked. The English language, like all other languages, is divided into vowels and so-called consonants. Authorities disagree as to the exact number of vowels for the reasons before given, and they also disagree as to the number of consonants. One reason of the disagreement is that some class all the sounds other than vowel as consonantal; others subdivide these, reducing the number of real consonants, and the disagreement is still further increased by the divisions not being always the same.

Again, there would be a difference as to the whole number of sounds to be called by any name. Accepting for the present the term *consonant* as including all sounds other than vowel, we find them classified as labial, dental, palatal, and nasal, each term bearing some relation to the locality in which the formative action takes place. There are various other divisions and subdivisions of consonants, making distinctions of great interest to the physiologist and phonologist, but which are also beyond the scope of our present purpose.

These interruptions to the phonetic stream are of equal importance to articulate speech with the vowel sounds, as the stoppage of a sound may become as distinctly associated with an idea and express it as the sound itself. This oral current, which by modifications, interruptions, and stops forms the consonants, is not a vocal stream like that of the

vowels, but it is a breath current driven from the lungs in the same manner, sometimes accompanied by vocal vibrations and sometimes not; nearly one half of the consonants are formed without voice, and are simply breath currents of greater or less force, modified by resonance or interrupted by the accessory organs. Every breath consonant in the English language

Fig. 9.



has its associated vocal fellow, i. e., in every instance in which a breath sound becomes an element in our language there is another element added by vocalizing a like breath current.

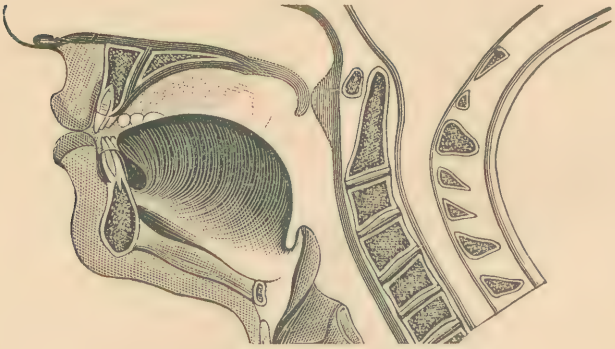
There are three definite points along the vocal pathway

Fig. 10.

where the voice is brought to a complete stop. They are the posterior margin of the palate, the alveolar border, and the

lips. Figs. 9, 10, and 11 illustrate these positions. In Fig. 9 the root of the tongue is brought into firm contact with the

Fig. 11.



palate. In Fig. 10 the tip of the tongue is in contact with the alveolar border immediately behind the front teeth, and in Fig. 11 the contact is by closing the lips.

There is no better way of making a description of the consonants appreciated than by beginning with the simplest articulate sound of childhood.

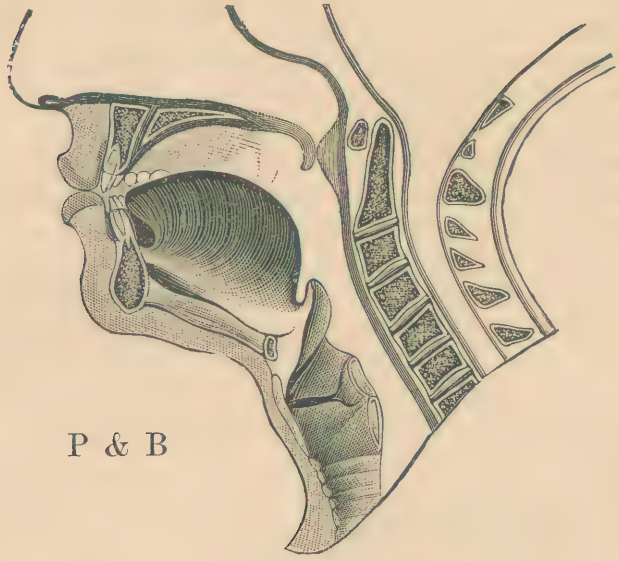
The first title applied to a parent is the easiest and most natural for infancy to pronounce.

Papa is simply the sound of P joined to the vowel AH. The vowel sound has been described; and to produce the sound of P, we have only to stop the sound of AH by closing the lips.

In making the sound of AH (see Fig. 3) all the principal as well as the accessory organs are in their most easy, natural, and unrestrained position. The sound of AH is but the natural voice of the child flowing out of the mouth, when it is stopped by closing the lips and suddenly opening them to allow the force of breath current to expend itself, and the sound of P is the result. It makes no difference whether the movement of the lips follows or precedes the emission of sound; the P lies in the act of closing and opening the lips joined to a vowel sound. Repeat this shutting of the lips upon the sound of AH with sufficient rapidity, and we have *Papa*, the

simplest and easiest word in the English language that a child can utter. (See Fig. 12.)

Fig. 12.



P is not simply a check or stoppage of a vowel; it must have an associated breath current for its completion. If it follows or checks the flow of a vowel, the lips must be opened to permit the escape of a little puff of breath, or the P is not complete.

When P begins a syllable this puff passes instantly and undistinguished into the vowel which follows.

P is a breath consonant and its associate vocal fellow is B.

Its formation is identical with that of P until the lips are closed, but after the closure the sound is not stopped, but continued in the buccal cavity, which is the distinctive characteristic of B.

It is not important that the sound be prolonged after the closure of the lips, but it is essential that it be momentarily heard in the confined buccal cavity.

As an experiment the sound can be prolonged, but only until the buccal cavity becomes filled with air, when it ceases.

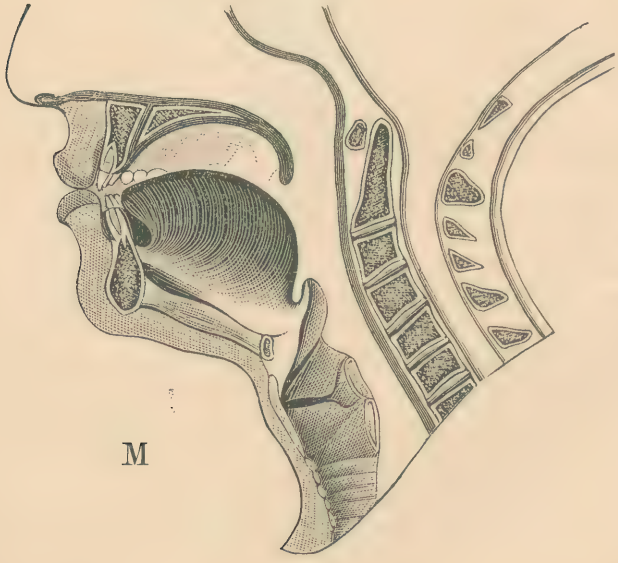
Like P, it matters not whether it precede or follow the vowel with which it is connected ; its value is the same. B is a vocal consonant.

In the formation of both P and B (see Fig. 12) the palate and pharyngeal wall are in contact.

Escape by way of the nostrils must be impossible, or the characteristic sound of B made by filling up the buccal cavity is lost.

Let the palate drop at the time of making B, and permit the sound to pass out at the nostrils, and M is the result. M is a vocal-nasal consonant, and its formation is identical with P and B in the closure of the lips, either preceding or following a vowel. Physiologically the difference between B and M lies solely in the position of the palate (see Fig. 13). We

Fig. 13.



thus see that P is the result of the complete stoppage of a vocal stream by the lips ; B is a stoppage by the lips, but the sound continued in the buccal cavity ; M, the same stoppage of a vocal stream by the lips, but the sound directed through the nasal passages where it may be prolonged indefinitely.

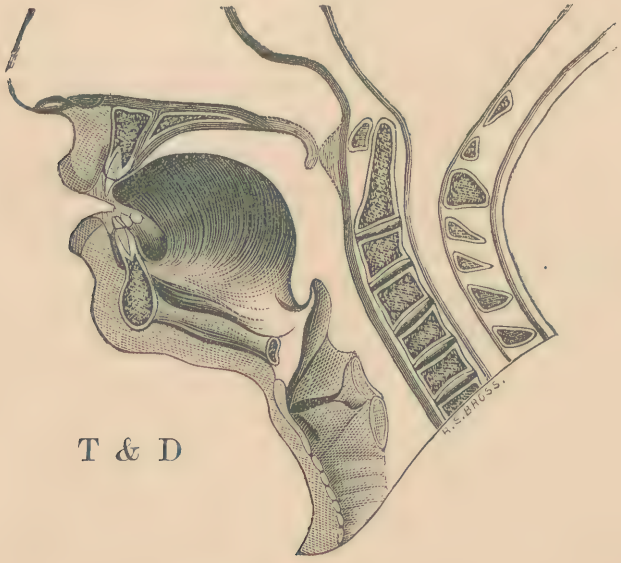
Any one interested in this subject can verify these experiments upon himself; indeed it is almost a daily occurrence that we meet some acquaintance whose Ms are all turned into Bs, by a stoppage of the nasal passages from cold or otherwise.

These sounds are called labial because the lips are principally concerned in their formation; the tongue does not necessarily come in contact with the roof of the mouth in their enunciation.

The mechanism of their production is confined to the lips and palate, and any contact of the tongue with the roof at the time is only incidental and dependent upon the vowel sound with which either of these consonants is joined. Thus in PAH or MAH there is no contact; but in PE and ME, the tongue will touch the roof at the sides, as seen in Fig. 7.

In considering the second class of consonant sounds termed *dental*, we may use another illustration from the child's vo-

Fig. 14.



cabulary—TA-TA. This syllable is as simple as papa, and its only difference is that in papa the lips stop the emission of

sound, while in TA-TA the vocal sound or vowel AH is stopped by placing the end of the tongue upon the gum immediately behind the front teeth, as shown in Fig. 14 and Fig. 15. The only physiological difference between P and T is that the current is stopped by the lips in the first, and by the tongue in the second. In all other respects they are equal.

Fig. 15.

Make the vowel AH and interrupt it rapidly as described, and we have the continued sound of TA-TA. In Fig. 15 we see that the conjunction of the tongue with the gum is not only in front at its tip, but extends the whole length of the alveolar border or dental arch. To make the sound of T, it must be in contact for this entire distance.

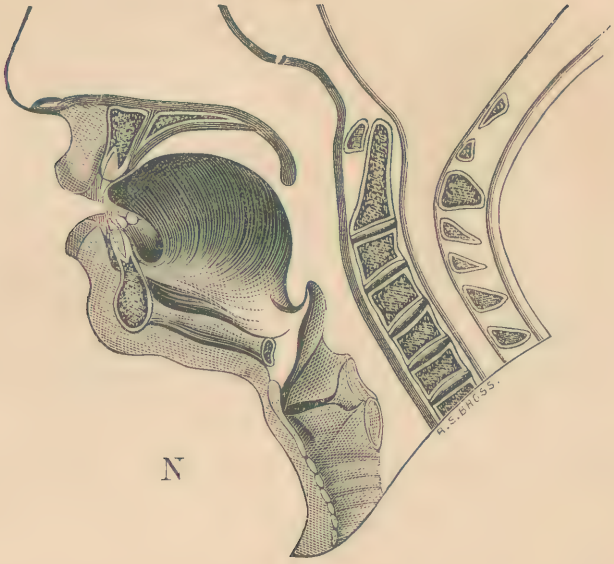
If the vowel sound were made with the tongue in contact only at the tip, and the sound escaping at the sides, L would be produced instead. It is this entire contact and escape only at the tip which gives the peculiar sound of T. This sound will be more readily apprehended, perhaps, by placing it after the vowel, as in *at*. T we call a breath consonant, the same as P, because the voice is not concerned in the formation of either. As we found B was the vocal associate of P, so do we find the vocal fellow of T to be D, and bearing the same relation. B was the filling up of the oral cavity with voice while the lips were closed either at the beginning or ending of a syllable; so is D formed by filling up the contracted oral cavity with voice, while the tongue is in contact with the roof of the mouth, as seen in Figs. 14 and 15.

We see here, also, the palate and pharyngeal wall are in contact, preventing all escape by way of the nose, and the sound of D may be continued until it fills the oral cavity, when it must cease by limitation of space.

But if now the palate be relaxed, so that the sound can escape through the nares, it may be continued so long as the

lungs can furnish the power to vibrate the vocal chords, but it is no longer D, but N (see Fig. 16).

Fig. 16.



The relaxation of the palate and pharyngeal wall change D into N, and, conversely, any enforced stoppage of the nasal outlet turns N into D. In my experiments I found that the surface of tongue contact with the roof was greater in N than in T or D (see Fig. 17); but I attribute this to the fact that N can be more easily prolonged than either of the others, and the contact is likely to become more general. This is probably more accidental than essential.

Fig. 17.

The third distinctly marked point at which the vocal current is interrupted is the posterior part of the oral cavity, and, like the other two, its function is the making of three sounds—a

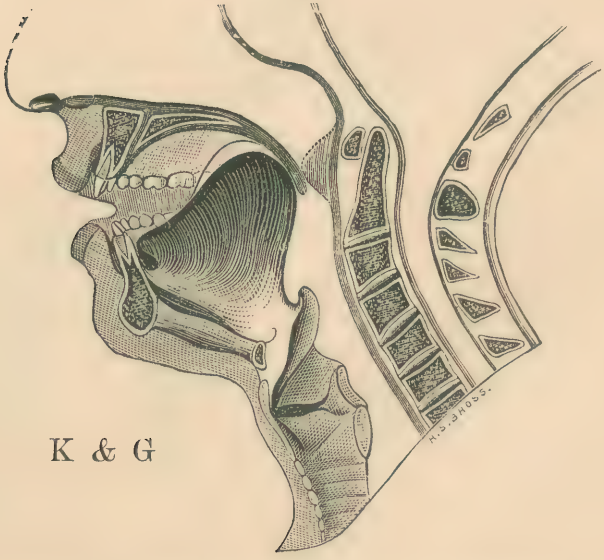
breath, a vocal, and a nasal sound. Thus, when the extreme back of the tongue is brought into contact with the soft palate in front of and above the uvula, closing the passage to the mouth, and at the same moment the upper part of the pharynx is advanced to meet the palate behind, and stop egress by the nares, the organs are in position to make K or G.

In the *cul de sac* thus formed above the larynx, the breath or voice accumulates. If breath only, the sudden relaxation of the tongue produces an explosion which is the sound of K. If the cavity be filled with voice until the relaxation comes, the sound will be G. These sounds are so intimately related that it is often difficult to distinguish between Ko and Go, when spoken by persons of loose habits of enunciation.

The essential requisite of G is that the sound be heard in the throat prior to its union with a vowel, or if it follows a vowel, as in *hog*, it must be made in the same way as above described.

In Fig. 18 is illustrated the position above described. In

Fig. 18.



my own case, I found that the tongue contact with the soft palate was greater in making G than in K, and this is indi-

cated in the illustration by a line showing the tongue at a higher elevation.

Fig. 19.

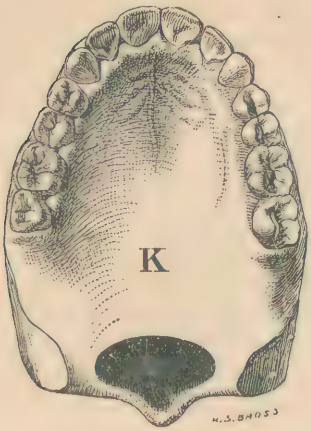
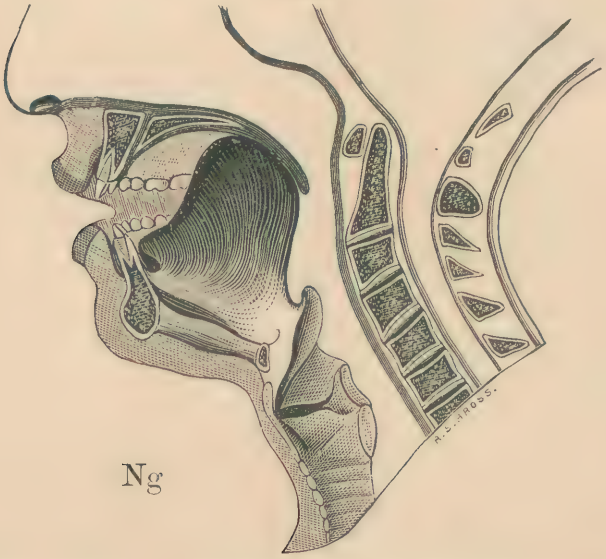


Fig. 20.

The difference is also seen in two other views, Figs. 19 and 20. Nevertheless, there is no physiological difference

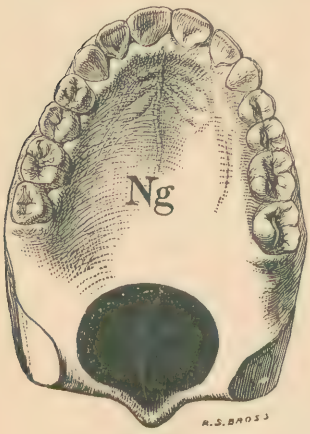
Fig. 21.



between them. A perfect G can be made with the limited contact of K.

The nasal sound of this group is NG, and is the result of the relaxation of the pharyngeal wall, while the tongue and palate are in continued contact. The sound which would otherwise be G is thus nasalized, and becomes a distinct elementary sound, for which our alphabet furnishes no character, and the only method of expressing it is by the combination of N and G, this being the sound given when those two letters are combined. The surface contact is also greater, as shown in Figs. 21 and 22, but this greater contact is not essential; it is only incidental.

FIG. 22.



There is another class of sounds which form an important part of articulate language of a different character from those we have been considering, and which are made principally in the front part of the mouth. Instead of being interruptions or checks to vowel sounds, they are continuous, and may be prolonged indefinitely. They are the result of a current of air driven through a small aperture, and are vocal or not, according to the sound desired.

For example: place the edge of the lower lip against the edge of the upper front teeth, and drive a current of air through between the teeth, or through a narrow aperture between the edge of the teeth and the lip, and F is the result.

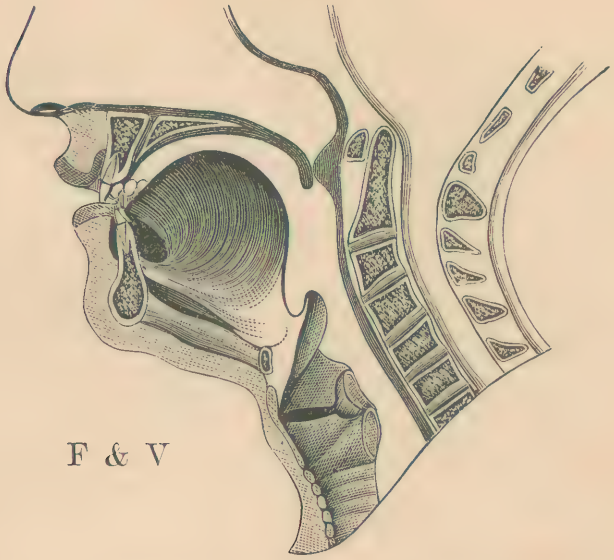
The termination of a vowel sound by a breath sound in this manner forms a syllable with F, or the reverse; beginning a vocal sound by a breath sound in this manner produces the same result.

We can change F into V by vocalizing the breath. The two are formed exactly alike; the current of air past the teeth being with voice in one, and without in the other.

In Figs. 23 and 24 are seen the positions of the various organs during their production, the contact of the tongue with the roof of the mouth being limited to a small space on the

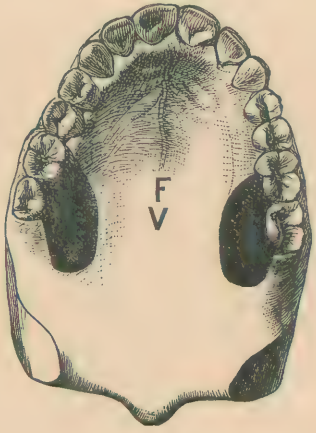
alveolar border, near the back teeth. Another pair of the same character is S and Z. S is one of the most important

Fig. 23.



sounds of the English language, and a defect in its enunciation is more noticeable often than any other sound. It is simply a current of air driven through a narrow chink, producing a hissing sound, the counterpart of which is frequently heard arising from a variety of causes outside of human speech.

Fig. 24.

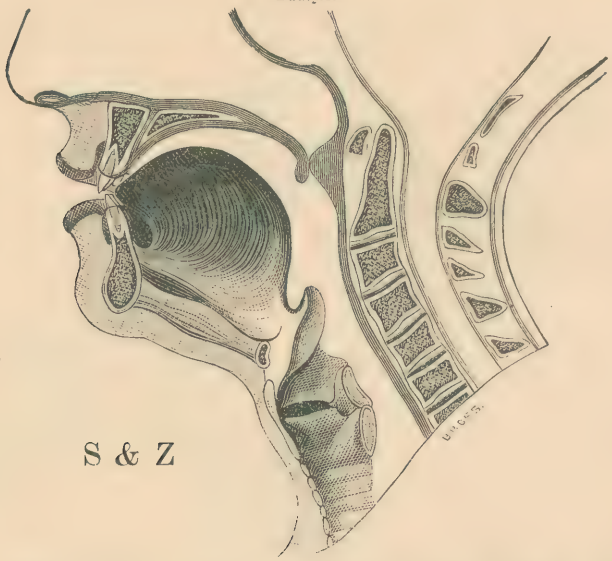


Place the tongue against the upper gum in the same way and position as when T is formed, but relaxing the end or tip and making a narrow passage for escape, as in Figs. 25 and 26.

The sound of S is formed by a current of air driven through this chink. Its corresponding fellow, Z, is a vocal sound, and is made with the tongue and

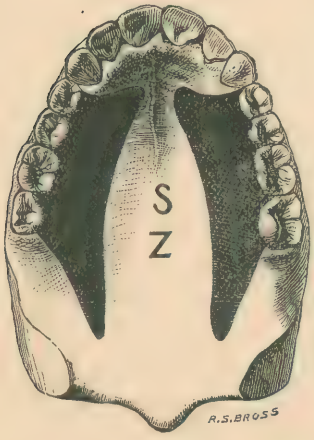
other organs in exactly the same position; but the breath current is vocalized in one, and unvocalized in the other.

Fig. 25.



A third pair of like character is SH and ZH—SH as found in *hush*, ZH as found in *azure*. These are not combinations of other sounds, as of S and H, but distinct elementary sounds for which our alphabet has no separate characters, SH being breath and ZH vocal.

Fig. 26.



The aperture for these sounds is similar to that of S, but wider and higher up in the roof of the mouth, which seems to take away the sharp, hissing sound characteristic of S. (See Fig. 28.) There is considerable latitude in making this sound, and its pitch may be varied considerably without seeming to affect its importance.

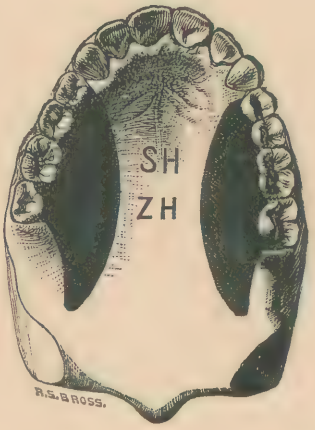
For example, the lips may be held as in P, or they may be considerably protruded. The

advanced position seems to be the easier and more natural, but the result for purposes of speech is essentially the same.

Fig. 27.

A fourth pair of the same kind is found in the two sounds of Th as heard in *thin* and *thou*, the former being breath and the latter vocal. In its formation, the tongue lies close to the gum against the back teeth, and the aperture in front is broad, similar to that in Sh, but the tongue is more advanced and lies closer to the front teeth and adjacent gum. (See Fig. 29.)

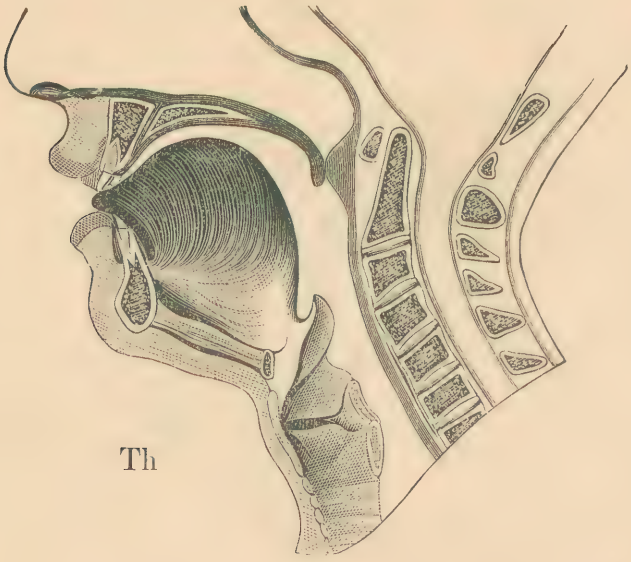
Fig. 28.



In Fig. 30, the firm contact is shown by the solid black, and the lighter contact by the shaded portion of the cut. There may be some latitude in the position of the tip of the tongue without materially affecting the result. The sound can be produced with the tongue projecting be-

yond the edges of the upper teeth, or retracted entirely within the dental border.

Fig. 29.



Still another pair of like character is formed with Ch and J; Ch being a breath sound, and J its vocal associate. It is claimed by some that these are not distinct sounds, but combinations of others already described, the former being made up of T Sh, and the latter of D Zh, but I found the tongue contact to be higher up and further back, as shown in Figs. 31 and 32, and therefore give them a separate description.

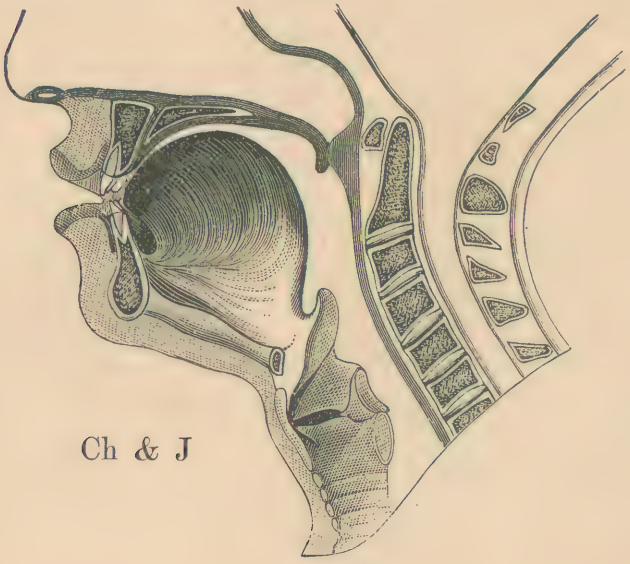
Fig. 30.

Practically it is of no consequence whether they be distinct sounds or a combination; the mechanism is so nearly the same as to be difficult to decide.

H, which usually remains unclassified, strictly belongs as

much to the same group we are considering as F, S, or Sh. It is an aspirate (rough or hard breathing) made in the throat,

Fig. 31.



and can not be specially illustrated. Its natural vocal associate is the vowel AH, and together they form a pair belonging to the class under consideration. In the minds of some, H seems to have been misapprehended in its formation and association with other sounds.

Fig. 32.

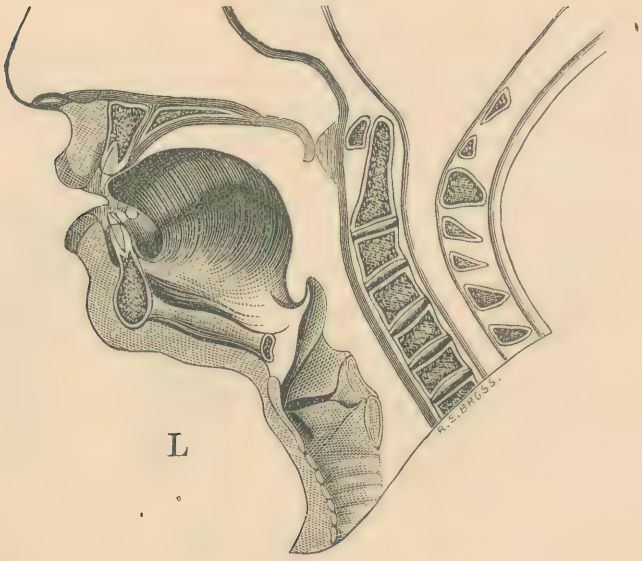
It appears to be the result of forcing the breath sufficient to create an audible current of air prior to the vibration of the vocal chords, and nothing more. Any other value it may have is derived entirely by resonance from the cavity or tube which it traverses. To produce the sound of H, there is not required any change in the position of the vocal organs from that which will admit of

quiet breathing. For example, a whistle may be placed between the lips, and all the respiration may pass through it without audible sound; it is only when force is used to create more rapid vibrations of air that the sound is heard. H is the sound of an air current without vocal vibrations, which sound is modified by resonance the same as the vowels.

This explanation of H is the explanation of the formation of whispered speech which by some has been considered mysterious. The only audible sound in whispering is that of a forced current of air; and the formation out of it of syllables and words is by resonance without voice, the resonating changes in the buccal and nasal cavities being identical with those when the vocal chords vibrate. It requires more lung power to produce this audible current of air than it does to produce sound by vibration of the vocal chords when they are under tension, and for this reason whispering is more tiresome than speaking.

A little reflection will show that in whispered speech there

Fig. 33.



can be no double consonants such as we call vocal and breath consonants. Vocal consonants can not exist in true whispered

speech; consequently whispered language is deprived of eight elements which enter into articulate speech. Papa and Baba in whisper are the same, so are also Ko and Go, etc.

We have thus described all the so-called consonantal sounds of the English language save two, and arranged them in two classes, the first class consisting of three groups of trios, and the second class of six pairs.

The two exceptions to this classification are L and R, both of which partake as much of the vowel character as the consonantal, and are usually called semivowels. L is produced by holding the tip of the tongue in contact with the gum as in T, but relaxing it at the sides, and uttering through this passage the vocal-current.

Fig. 34.

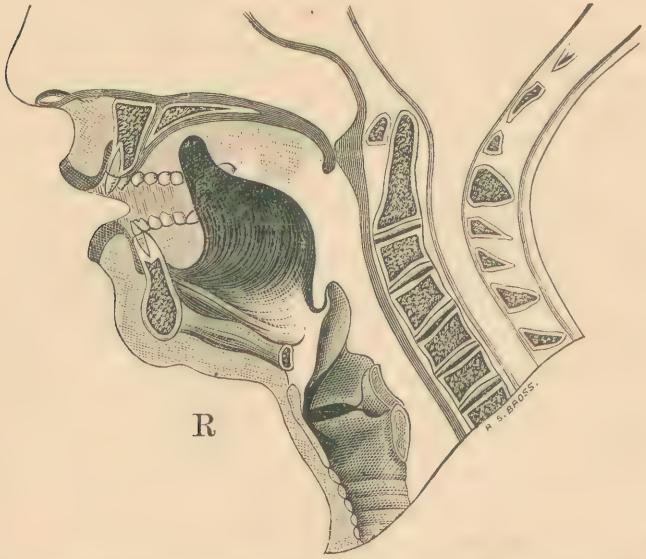
In Fig. 33, this relaxation of the sides is shown by a lighter band across the tongue. In Fig. 34, this contact with the roof of the mouth is seen to be only in front. L also receives some characteristic augmentation from the vibrations of the sides of the tongue as the current passes.

Physiologically the sounds of L and D are so nearly alike that D is confined in the mouth and L escapes at the sides of the tongue, all the other organs being in the same position. Their near relationship is readily observed by the ease with which they are both sounded in words where they come together, as in "handle"; the L then takes the place of a vowel, the two sounds blending without the interposition of a vowel. During its production the palate and pharyngeal wall must be in contact, or the sound will be imperfect. Although not entirely destroyed, it will be nasalized by the escape.

In Fig. 35 is shown the position of the tongue in making the sound of R. The oral cavity at the time of the formation of this sound corresponds with that in the production of the vowel AH. In fact, many people sound R so slightly that it

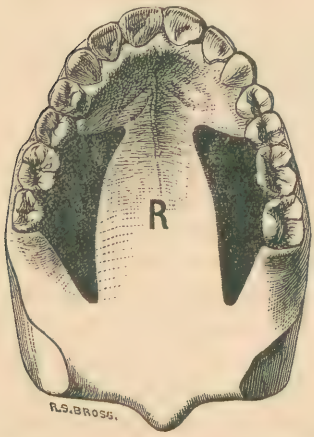
is little if anything more than the vowel AH. But the formation of R requires that the tip of the tongue should be point-

Fig. 35.



ed upward and vibrated while the current is passing. With some the tip of the tongue is distinctly felt against the roof of the mouth during these vibrations; while with others it is below, as represented in the illustrations. Neither does it seem requisite that the tongue should be pointed to the same locality in the roof—it may be farther forward or farther back. The sound of R is produced by the rapid interruption of the voice, in the above-described manner, in the middle of the mouth. In some languages this sound is much more marked and distinct than it is generally made in English. With some English-speaking people it is an affectation of refinement to banish it almost entirely.

Fig. 36.



The foregoing explanation comprises nearly all the distinct sounds which form the English language. The sounds of the other letters of the alphabet not here named are either repetitions or combinations of those described, or are not so distinctive in their mechanism as to be illustrated by diagrams. For example, C is a repetition of K, or S, as it is used either hard or soft. G soft is the same as J, and W is so nearly the vowel "OO"* that a diagram can not illustrate any appreciable variation. X is a combination of K and S, etc., etc.

The foregoing descriptions and diagrams are not advanced as the only method by which the different sounds they illustrate can be produced. They are nevertheless believed to be the arrangements of the various organs which are universally found to be the easiest, and most in conformity with physiological function. As a scientific experiment many of the sounds can be perfectly produced or closely imitated in some other way. For example, S can be made with the tip of the tongue curled backward in the roof of the mouth, T may be made with the tongue placed at various points, etc., and even musical instruments and machines can be made to produce vowels, and to a limited degree consonants.

Children do not place their organs for articulation as the result of scientific teaching, but as the result (not the cause) of the effort to imitate the sound, and as the action of the organs acquired in that way is almost universally identical, it proves the one to be normal and the variations abnormal. I have adopted the usual divisions and designations of vowels, consonants, and semi-vowels, but it is a classification that will hardly satisfy any one who becomes familiar with the subject.

Of the so-called consonants, nearly one half are not *consonant*—i. e., *with sound* (vocal sound) or *sounding with;* P, B, T, D, K, and G are called *mutes;* but B, D, and G are certainly not mute, nor are P, T, or K any more mute than F, Th, or others.

* Bristowe says: "The sound of the English vocal *W* differs from the vocal *OO* mainly in the fact that the fundamental vowel sound is produced in the larynx, and receives its coloring from the oral cavity; while the distinctive sound of the consonant, though also colored by the resonance of the oral cavity, is manufactured at the labial orifice."

The following table shows a classification more in accordance with their mechanism. This table, proceeding from right to left, may represent the oral tube or cavity from the vocal chords to the lips inclusive, and the sections indicate the points along the line where the sounds are made or checked:

	Contact of both Lips.	Teeth and L. p.	Tongue and Teeth.	Tongue and Gum.	Tongue and Gum.	Tongue and Gum.	Tongue and Roof.	Tongue and pala. e.	Throat.
Breath	P	F	Th	T	S	Sh	Ch	K	H
Vocal	B	V	Th	D	Z	Zh	J	G	Ah
Nasal	M			N				Ng	
				First position.	Second position.	Third position.			

The foregoing explanation of the mechanism of vocal articulation supposes the normal integrity of all the organs concerned, each fulfilling its natural function. In the production of all the vowel sounds of the English language the veil of the soft palate is elevated and hugs the posterior wall of the pharynx. This is essential to the formation of resonating cavities of uniform tone-character. Consequently, if the palate be destroyed or congenitally absent, a new resonating cavity is exposed, and the tone-character of the buccal cavity is changed. These sounds can no longer be made in the same way, and in many cases can not be made in their purity at all.

In some other languages, the French, for example, nasalized vowels and other nasal sounds form an important part of the speech, but when such sounds are introduced into the English they destroy its purity.

A dissertation on the mechanism of speech would be left

incomplete if it were confined to articulation with normal organs alone. It is a remarkable provision of nature that in many cases destruction of an organ does not involve a destruction of the function performed by it, and this is notably the case with vocal articulation. The teeth may be suddenly destroyed, and at first the effect seems disastrous, but very shortly the lips and tongue accommodate themselves to the change, and the function of the teeth in articulation is nearly or quite regained. The palate, which performs such an important office, may be destroyed, and its loss compensated for in a great measure by an increased activity of the pharyngeal muscles and a new use of the muscles of the nostrils. The phenomena in abnormal articulation are often truly remarkable. In my practice of treating congenital and accidental lesions of the hard and soft palate, I have seen nearly every conceivable variety of deformity and have observed the phenomena. In congenital cases the absence of the palate is often compensated by an extraordinary use of other organs in a manner that would seem impossible. The inability on the part of some to make this compensation gives greater variety to the phenomena, so much so that it is quite impossible to declare by an observation of a defective palate without the aid of the ear what its effect is upon the individual's speech. Neither the size nor the extent of the deformity will determine the effect upon articulation because of this compensation by other organs. A few examples from practice will illustrate these points:

A lady, about thirty years of age, belonging to the higher grades of society, of intelligence and education suited to her station, came to me for treatment. The fissure of the palate was confined to the velum, the apex of the cleft reaching only to the edge of the hard palate. I wrote upon a slip of paper the following syllables: GO, KO, SO, HO, JO, DO, CHO, NO, TO, and repeated them on the slip several times promiscuously, and handed it to her to pronounce aloud as distinctly as possible. Of the whole list, HO, JO, and NO were the only ones that could with certainty be distinguished. All the rest were alike pronounced NO. No difference whatever appeared between her GO, KO, and SO. Theoretically,

the S and CH were in her power to make perfectly, and D and J approximately, and K and G the only ones theoretically impossible. No amount of training from infancy had served to develop these sounds, which came to her only after the introduction of an apparatus.

In another case of an Irish girl in the lower walks of life, nineteen years of age, with a fissure exactly similar to the foregoing, the same experiment was tried, with additional syllables of a more complicated character—such as ist, idst, ox, etc. This experiment was tried before the introduction of any instrument, in the presence of a number of surgeons, who were only governed by their hearing in determining her pronunciation. Every syllable was so distinct that it was not mistaken by any one. In this exercise the listeners were not aided by any knowledge of the syllable before it was spoken by the patient. The only criticism was the nasalization which, when she came to read or in conversation, made her speech disagreeable. Theoretically, her K and G should have been entirely wanting, but they were so clear that she was not mistaken in a single instance.

A third case was as follows:

A father brought his son to me—a young man of mature years, who had fissure of the soft palate only. I was not favorably impressed with the intellectual development of the young man. He seemed stupid, and had but little realization of his own condition. His speech was very bad—much worse than most cases where the fissure is no larger than his. His reading was a monotonous, half-idiotic sound, with but little distinction of vowels, consonants, syllables, or words. After two or three interviews I came to the conclusion that it would be hopeless to expect any improvement from him in the use of an artificial palate, and I frankly told the father that I could not encourage the undertaking. Upon being urged for reasons, I stated them as delicately as possible, as being based on what seemed to me to be defective mental power. But such an intimation was not to be listened to by the fond parent, who saw no reason why "his boy" should not have an artificial palate as well as any one else, as he was ready to pay for it.

After a complete understanding by them of what would be necessary for him to do for himself after my work was done, I made and adjusted the appliance. Within the same hour after its introduction, I sat him before me and directed him to imitate exactly every motion of my lips and every sound of my voice. After a half hour's training he enunciated every sound of the English language with all the distinctness and precision of one with well-formed organs.

This he would do under my dictation, executing my will almost as if he had no will of his own—not only sounds, but words and sentences were repeated with clearness and distinctness, and I began to repent the discouragement I had given them. But passing from my dictation he dropped into his former habit of monotonous indistinctness, and I became less hopeful of ultimate results.

Another case was that of a young lady, sixteen years of age, unusually bright and intelligent, with fine musical and artistic taste. The fissure extended through both hard and soft palates to the base of alveolar ridge. Externally there was a hare-lip, which had been operated upon in infancy. With this patient K, G, and S were impossible. By no effort could she make any sound approximating to K or G, and her effort to make S was a gurgle in the throat. CH was unattainable, as well as such combinations as ist, dst, ks, etc. So sensitive was she to the defect that she kept herself from society, and was growing morbid under her affliction. Realizing her utter inability to pronounce some words, she finally formed the habit of avoiding the use of such words in her conversation, and either used synonyms or expressed the idea by a differently constructed sentence.

I constructed an apparatus for her, and three years afterward she read before the same company of surgeons before referred to.

She had conquered every sound singly and in its more complex combinations except S, and this was still made in the throat. It was nevertheless made distinctly, and could not be mistaken for any other sound, but it was made improperly, and was wanting in the sharpness which characterizes S.

K and G were perfect, and the former nasalization of the vowels had passed away.

An entirely different manifestation from any of the preceding was that of a man thirty-five years of age, who had double fissure of the palate complicated with double hare-lip. The lip had been very skillfully operated upon in early life. He had grown a heavy beard and mustache, and as the suture of the lip was on the median line the parting of the mustache was natural and graceful, and there was no external suggestion of any deformity. The intermaxillary bone had been removed, and all the incisor teeth, leaving a wide gap between the two sides of the maxillæ, covered in front by the lip. Fig. 37 represents a model of the mouth referred to. A A shows the bifurcated uvula at the extremity of the remnants of the soft palate, which is here shown as drawn up under the action of *levatores palati*. B is the superior pharyngeal constrictor, drawn forward and in contact with the uvulæ. C C shows the palato-pharyngeal muscles, the borders of the pharynx, and D D the palato-glossus. The vomer and turbinated bones are seen exposed in the anterior part of the nasal cavity.

Fig. 37.

In this case, the sounds of TH, T, D, S, Z, SH, ZH, CH, and J were entirely wanting.

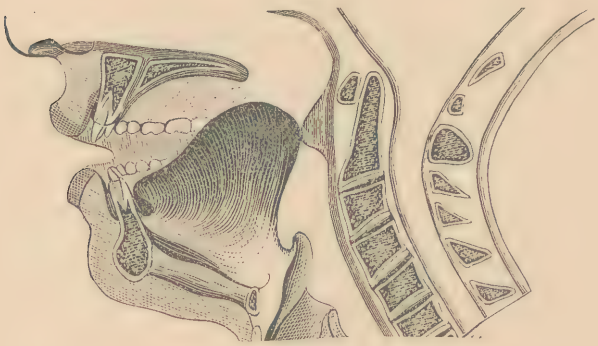
His speech was so bad that in giving him a passage to read before an audience not a word of all he read was understood by his hearers, and yet this man could pronounce the sounds of K and G with the utmost clearness and distinctness, not to be misapprehended or misunderstood.

The phenomenon was a mystery to me until, in my further experiments with him, I discovered that he brought the root of the tongue and the advanced pharyngeal wall into contact.

The absence of so important an organ in normal articulation was here compensated for by a little greater activity of the pharyngeal constrictor and the tongue. This action of the superior constrictor of the pharynx could be very plainly observed by tickling it with a camel's hair pencil when the patient's mouth was open, when it would develop into a strongly marked ridge or cord horizontally across the pharynx.

The formation of a *cul de sac* above the vocal chords, essential to the production of K or G without the interposition of the palate, is shown in Fig. 38. The sounds of T, D, etc.,

FIG. 38.



were impossible because the necessary obstruction to the tongue in their formation was wanting, and art must be resorted to, to supply a barrier.

Altogether the most extensive deformity of this kind, and the one having the most disastrous influence on the speech that I have ever seen, was a young man upon whom Professor J. L. Little, of the College of Physicians and Surgeons, New York, operated for compound hare-lip, and who afterward came into my hands for an artificial palate.

The patient was nineteen years of age, and up to that period no operation had ever been performed upon the lip. The deformity was horrible. The intermaxillary bone with its integument was suspended from the septum of the nose nearly at its tip, and behind it there was no upper lip what-

ever. There was no roof to the mouth from front to rear; the gap was the widest I had ever seen. So also was the distance across the jaw from the outside of the molar teeth, and the distance between the canines, the greatest I have ever measured.

Dr. Little was very successful in his operation on the lip, removing the deformity entirely.

Previous to the introduction of an artificial palate, the following described experiment was tried in the presence of a number of distinguished surgeons. I wrote upon a slip of paper the following syllables, which the patient pronounced to the best of his ability, repeating each one several times: BO, SO, TO, HO, MO, FO, KO, PO, GO, DO, ZO, JO, NO, VO, CHO, THO, SHO, RO, HO.

The sound given by him to each of these syllables was written by the gentlemen present as nearly as they could be understood.

A comparison of the various records showed that the only unmistakable syllables of the whole list were KO, GO, and HO: all throat sounds.

Of the doubtful ones NO and MO were interchangeable, and so were LO and RO; and of all the others, no sound that he gave was any clew to the syllable he was trying to pronounce.

The explanation of his inability is not difficult. It was quite impossible for him to make the labial sounds when he had no upper lip, and in the short time which had elapsed since Dr. Little's operation he had not learned to use it, and the absence of any alveolar ridge in front prevented the formation of all dental and other sounds made in that locality.

One of the most peculiar features of this case was the production of K and G.

In all other cases of similar character the action of the superior constrictor of the pharynx could be seen when irritated and examined, but I could excite no visible action in him, and to ascertain where the conjunction was which formed those sounds I tried the following experiment: Pulling the tongue forward, I painted the back wall of the pharynx with

some chalk and water and required him to articulate K or G; and then pulling the tongue again forward, the contact was marked by a transfer of the chalk to the tongue, but at a lower point than I had ever seen before in any person.

It was not the superior constrictor, but the middle constrictor which was in action, and at a point a little above the glottis.

The foregoing examples are sufficient to illustrate the variety of phenomena observed with congenital cleft-palate people.

In cases of such persons as have lost the whole or a portion of the palate by accident or disease, the result is an immediate convincing proof of how articulation is normally accomplished. Any considerable perforation or loss of the roof of the mouth makes recognizable speech impossible. Such people, after a time, overcome some of the difficulties, partly by a use of the nasal constrictors and partly by an increased activity of the pharyngeal constrictors.

But as these lesions generally occur in adult life, the sufferers rarely acquire the same facility seen sometimes in congenital cases. Nevertheless, a simple apparatus filling or covering the perforation restores normal articulation immediately.

The following description of such a condition is copied from the "Argus," Bainbridge, Georgia, August 22, 1868:

"All persons acquainted with us (the editor of this paper) are aware of the loss of speech which we sustained in early life by scrofula. This almost totally disqualified us for any business calling us beyond the circle of our immediate friends and associates. A stranger could rarely understand a word we might say. Believing that a kind Providence pointed to our restoration through the agency of art and science, we visited New York on the 10th of June, and remained in the hands of Dr. Norman W. Kingsley until the 18th ult.

"We thank God that we are enabled to state to our friends that, by means of an artificial palate put in our mouth by Dr. Kingsley, our speech has been entirely restored, and we are now, for the first time during the last twenty-eight years,

qualified to converse freely with any one without the slightest inconvenience or embarrassment, and without being misapprehended or misunderstood in any word or sentence we may utter.

"It has proven a very great relief to us, so much so that our past life seems to have been an uninterrupted blank."

HEALTH,

AND

HOW TO PROMOTE IT.

BY

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"L'aisance et les bonnes mœurs sont les meilleurs auxiliaires de l'hygiène."—BOUCHARDAT.

Extract from Preface.

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